Assessment and Modelling of Baltic Ecosystem Response (AMBER)

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BONUS+ Kick-off Conference

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Participants

- Leibniz-Institute for Baltic Sea Research Warnemünde, D (Coordination)
- Leibniz-Institute for Freshwater Ecology and Inland Fisheries, Berlin, D
- Institute for Hydrobiology and Fisheries Research, University Hamburg, D
- Swedish Meteorological and Hydrological Institute, Norrköping, S
- Department of Applied Environmental Science, University Stockholm, S
- Department of Biological and Environmental Sciences, University Helsinki, FI
- Archipelago Research Institute, University Turku, FI
- Coastal Research and Planning Institute, University Kleipeda, LIT
- Institute of Oceanography PAS, Sopot, PL

Climate Change Scenarios

economical oriented

A1 A2

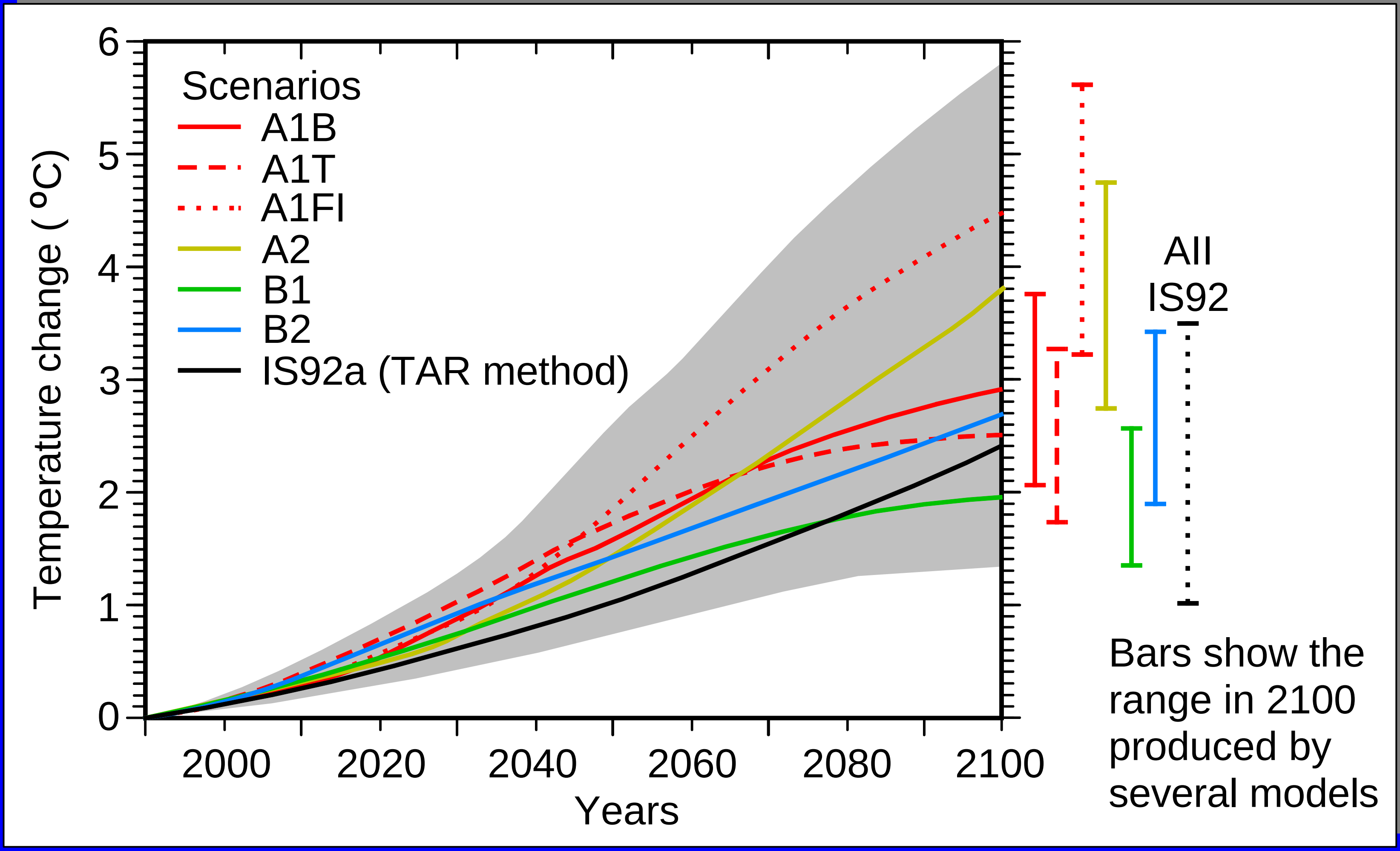
global regional

B1 B2

ecological oriented

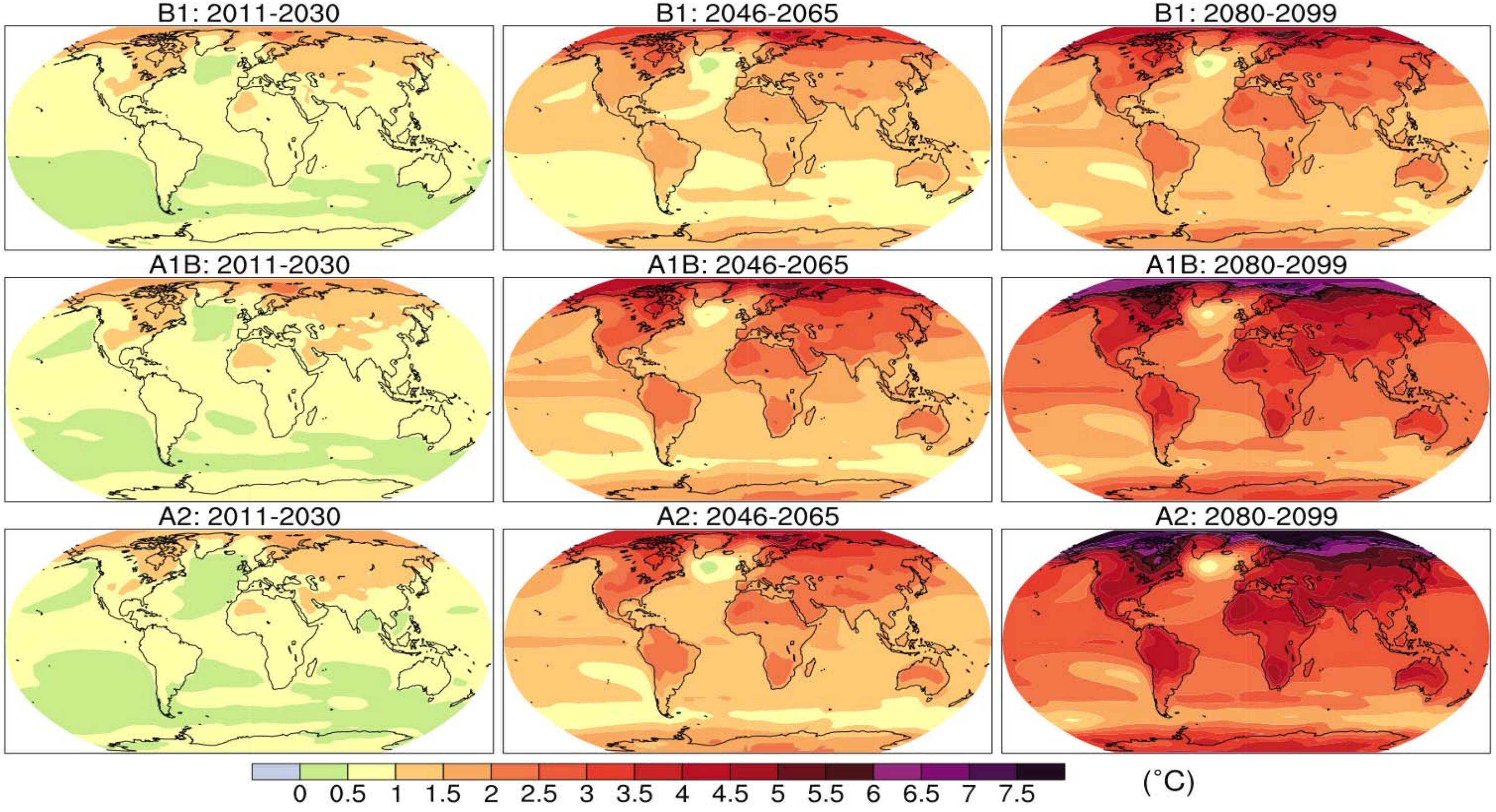
IPCC 2007

Global Warming



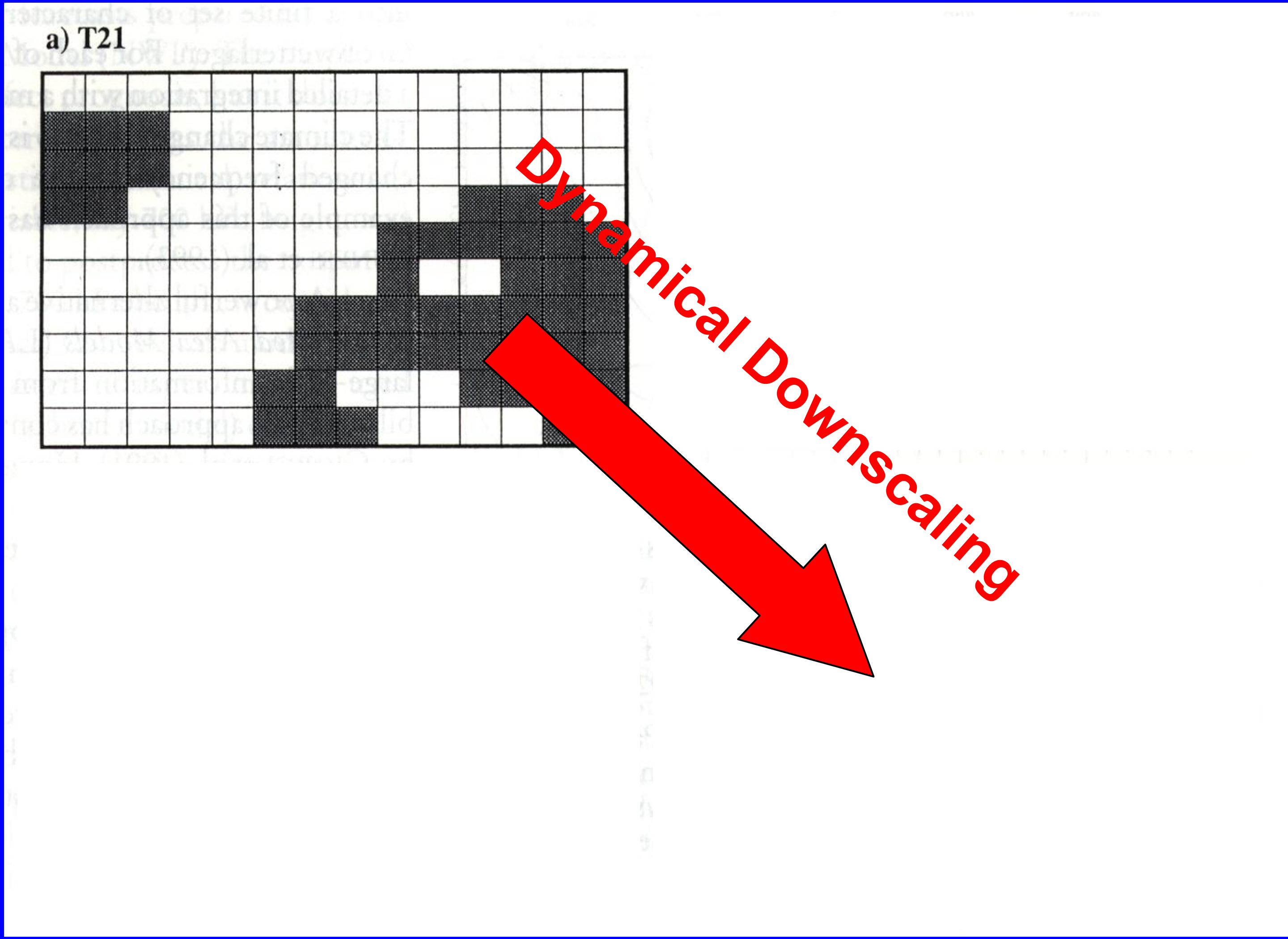
IPCC 2007

IPCC Scenarios

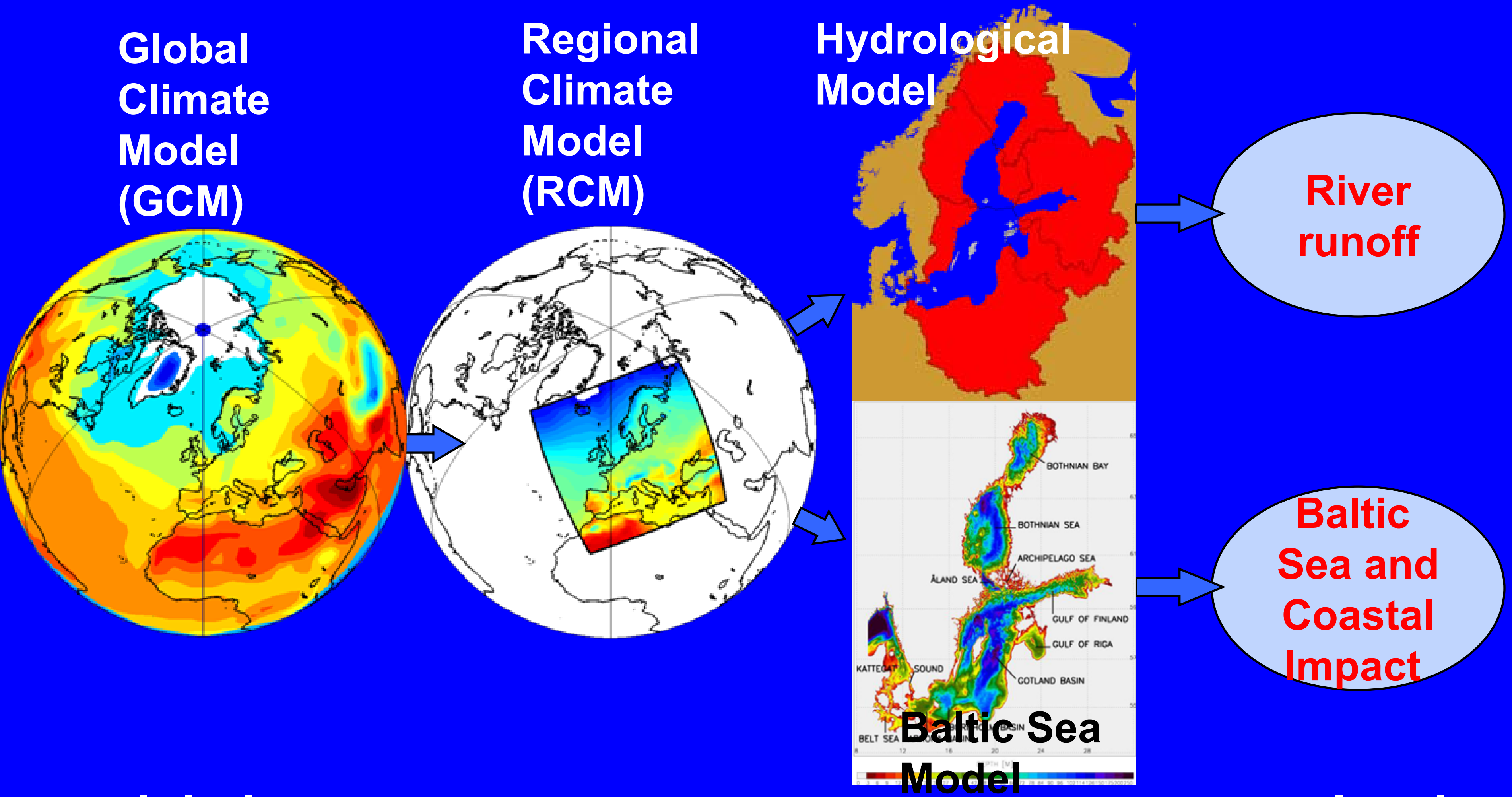


IPCC 2007

Grid Resolution in Models



Future Climate Change



global ⟷ local

Scale

BACC 2008

Projection of Climate Change (2100)

- Increase of air temperature ~ 3 – 5°C
- Increase of sea surface temperature ~ 2 - 4°C
- Decrease of ice extent ~ 50% - 80%
- Decrease of salinity ~ 8% - 50%
- Risk of floods on south- and east-coasts
- Winter becomes wetter, summer drier
- Increase of river runoff during winter ~ 50%
- Decrease of river runoff during summer ~ 20%
- No robust results for wind and storms

BACC 2008

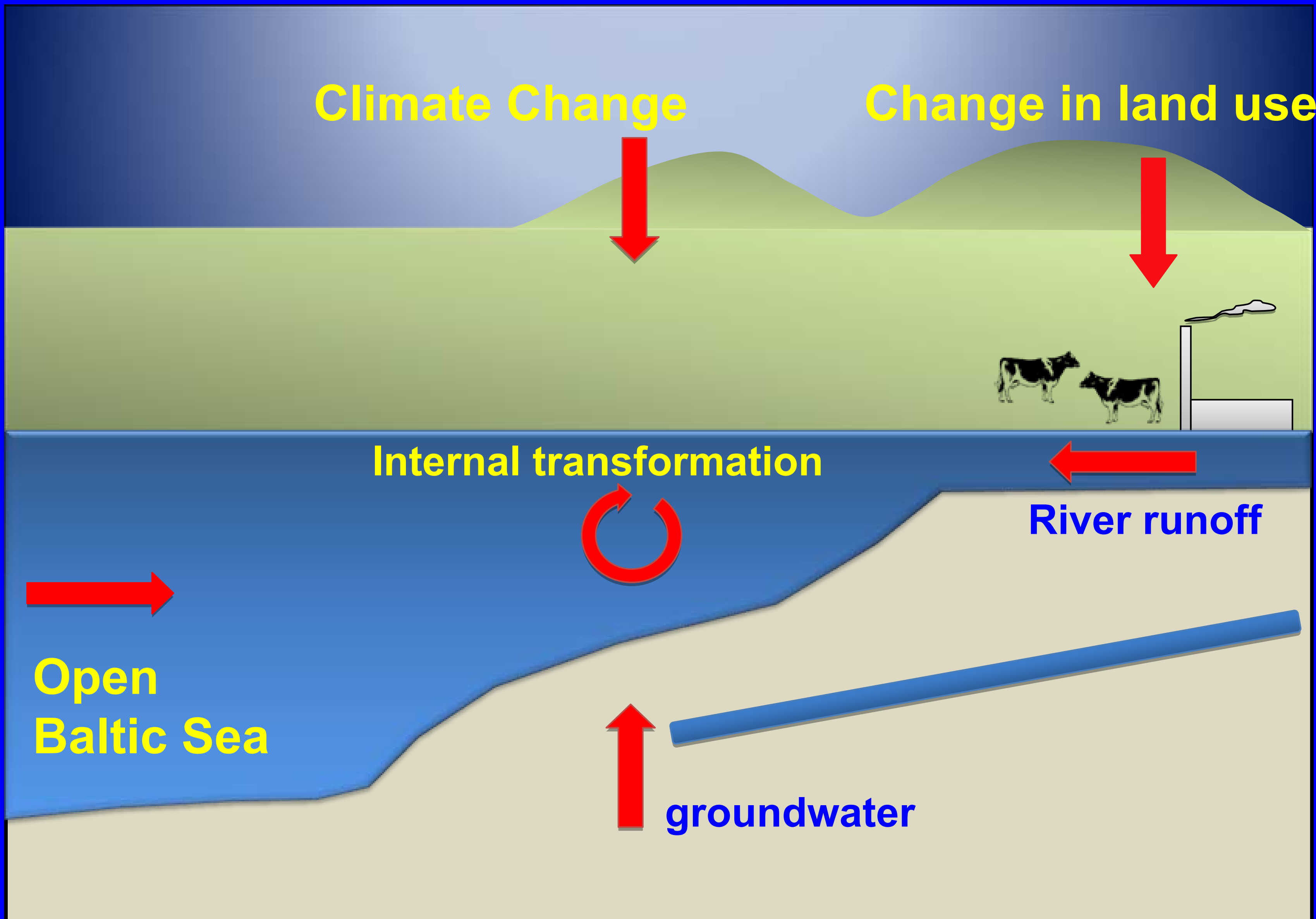
AMBER - GOALS

- Implementation and application of the Ecosystem Approach to Management (EAM) to the Baltic Sea in the face of eutrophication and climate change
- Focus is the coastal ecosystem in a holistic view
- Separation of climate from anthropogenic signals
- Combination of different climate change scenarios with land use/life style change scenarios
- Science based advise for integrated management
  - Risk assessment
  - Mitigation strategies
  - Ecological Quality Objective
  - Improvement of monitoring strategies
  - Fisheries management

Methods

- Retrospective analysis of long-term data sets
- Measurements of biogeochemical transformation processes in the coastal waters
- Measurements of fluxes into the coastal area from cold seepages
- Climate modelling
- Ecosystem modelling
- Catchment modelling
- Combination of climate and catchment models
- Implementation and application of EAM

The near coastal area



Research Clusters

- A) Time series analyses
  - Climate change
  - Open Baltic Sea
- B) Process studies and observations
  - Internal transformation
  - River runoff
  - Groundwater discharge
- C) Spatial river basin–coast–sea interaction
  - Change in land use
  - River runoff
  - Combined modelling
- D) Policy and advisory
  - Implementation of EAM
  - Application of EAM

Research Cluster A

- Updated data collection
- Retrospective data analyses
- Analysis of potential predictability (POP)
- Prediction of future changes (statistical downscaling)
- Analysis of future development of Baltic ecosystem (AMOEBA)
- Analysis of optimal environmental window (Cury & Roy Model)

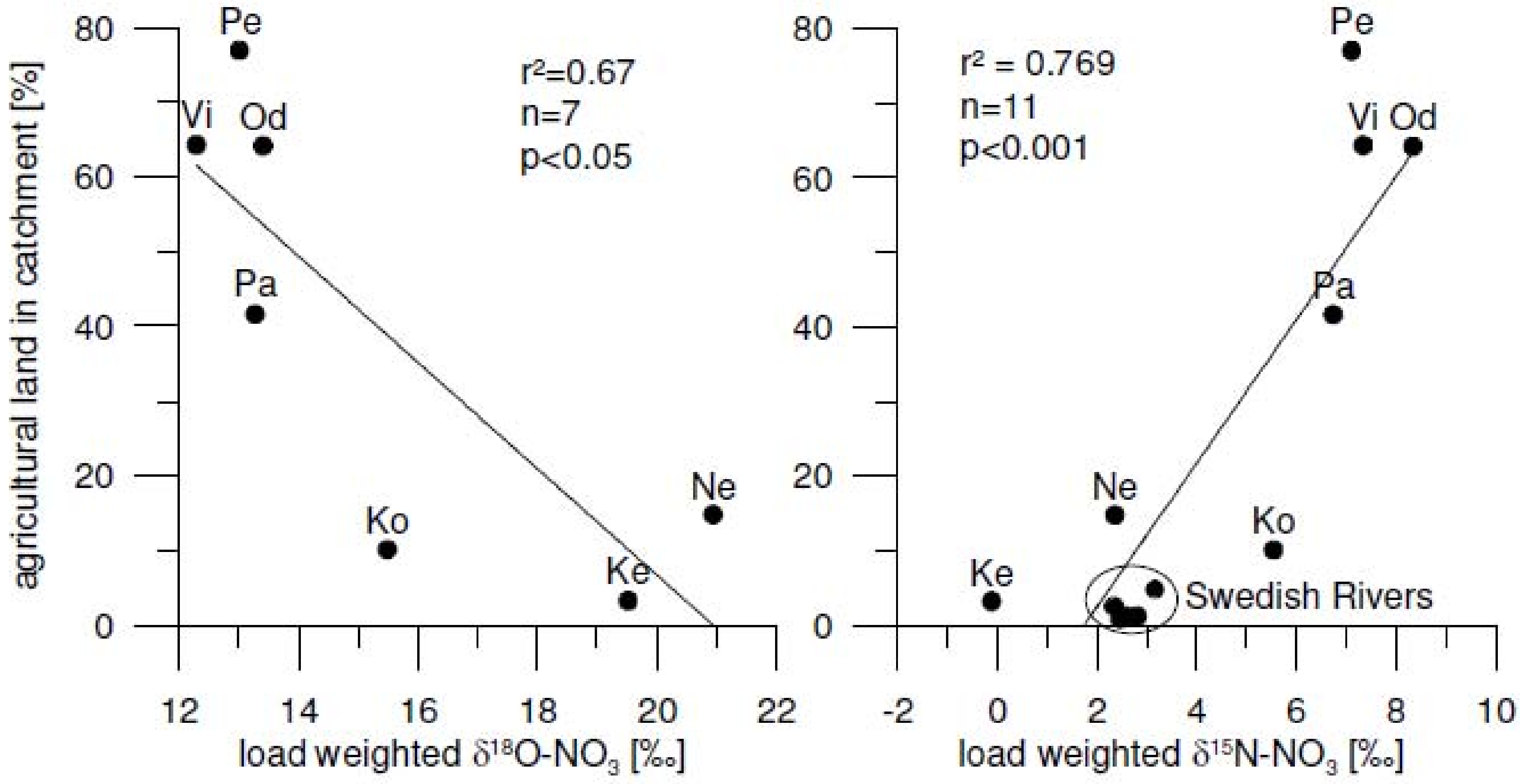
Research Cluster A (Example)

- Background is the documented increase of rain fall for the last 40 years.
- Modelling Baltic Sea runoff from 1970 to 2000 in order to separate years with low and high runoff
- Modelling relations between low and high runoff and its consequences on nutrients and biota.
- **We should be able to point out a chain of events from Baltic climate conditions to species level in biota and more general changes e.g. eutrophication**

Research Cluster B

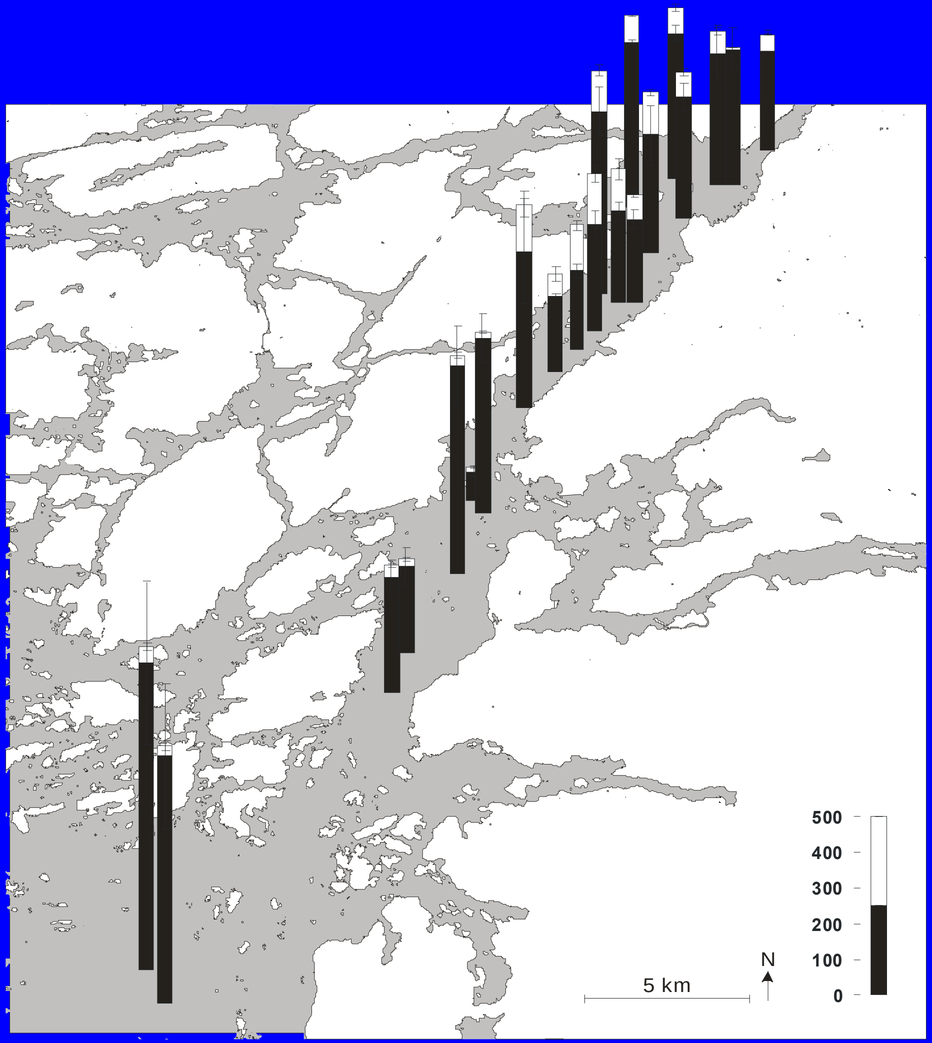
- Estimate of N-removal in contrasting estuarine systems
- DOM input and transformation in Baltic estuaries (bioavailability of DON for food web)
- Isotopic signature in nitrate for source identification
- Identification and quantification of submarine groundwater discharge
- Geochemical composition of groundwater seepage
- Groundwater seepage impact on biota

Isotope signals of Nitrate in Baltic Sea rivers is related to land use



Voss et al. 2006

How much of the nitrogen loading do natural processes remove before river waters enter the sea?



Paimionlahti Bay Aug-Sep-03

Average denitrification

420 µmol N m^{-2} d^{-1}

(= 2 g N m^{-2} a^{-1})

NOx removal 4.5%
Ntot removal 19%

of loading in August-September 2003

Silvennoinen et al. 2007

Submarine Groundwater Discharge

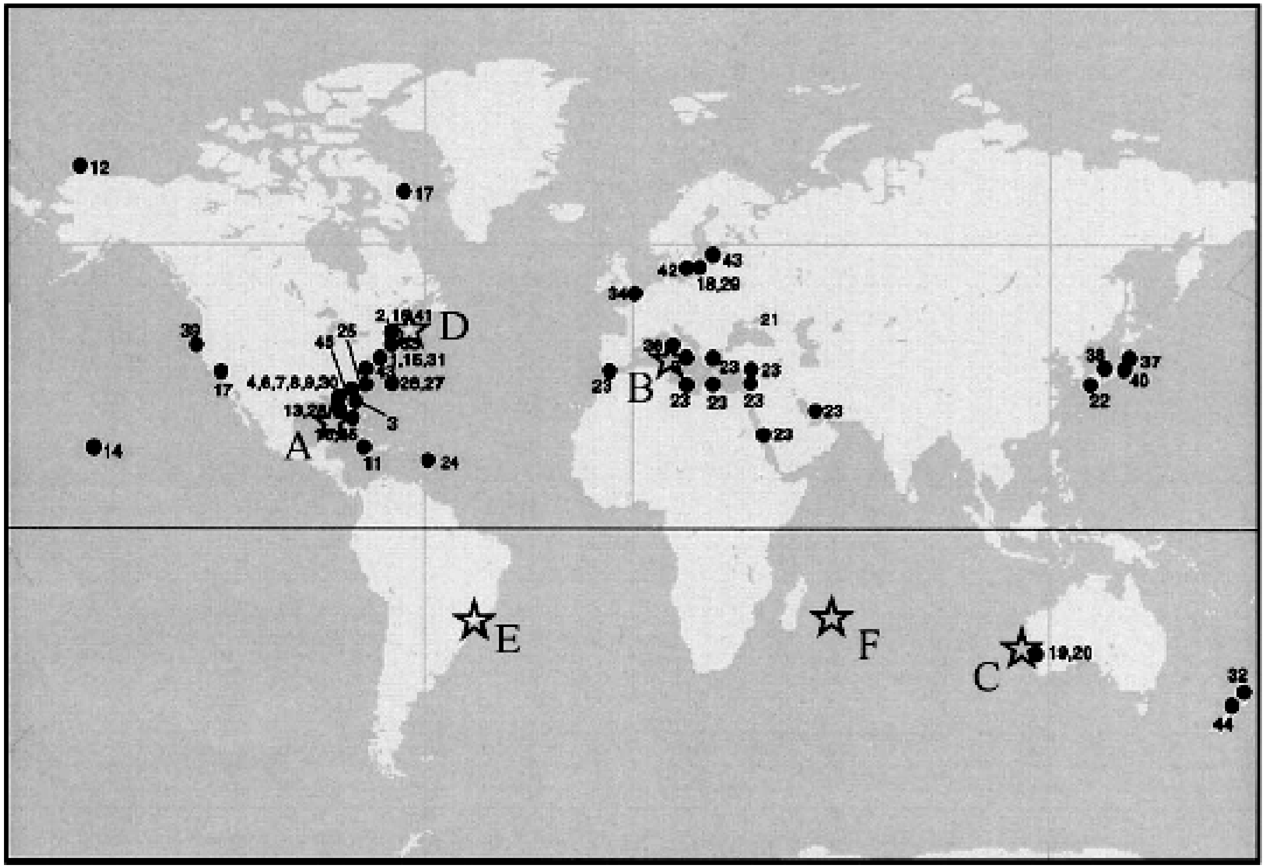
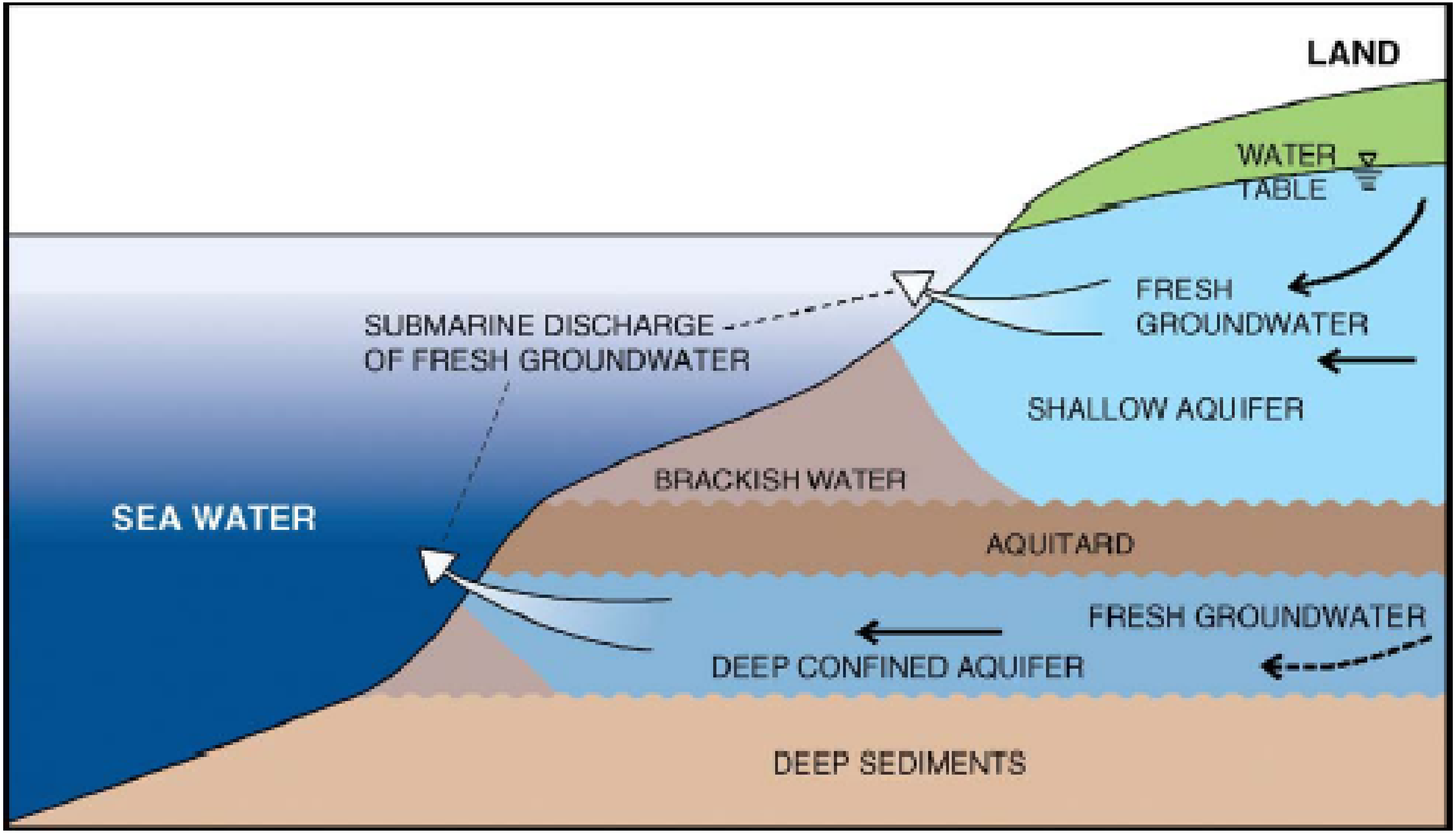


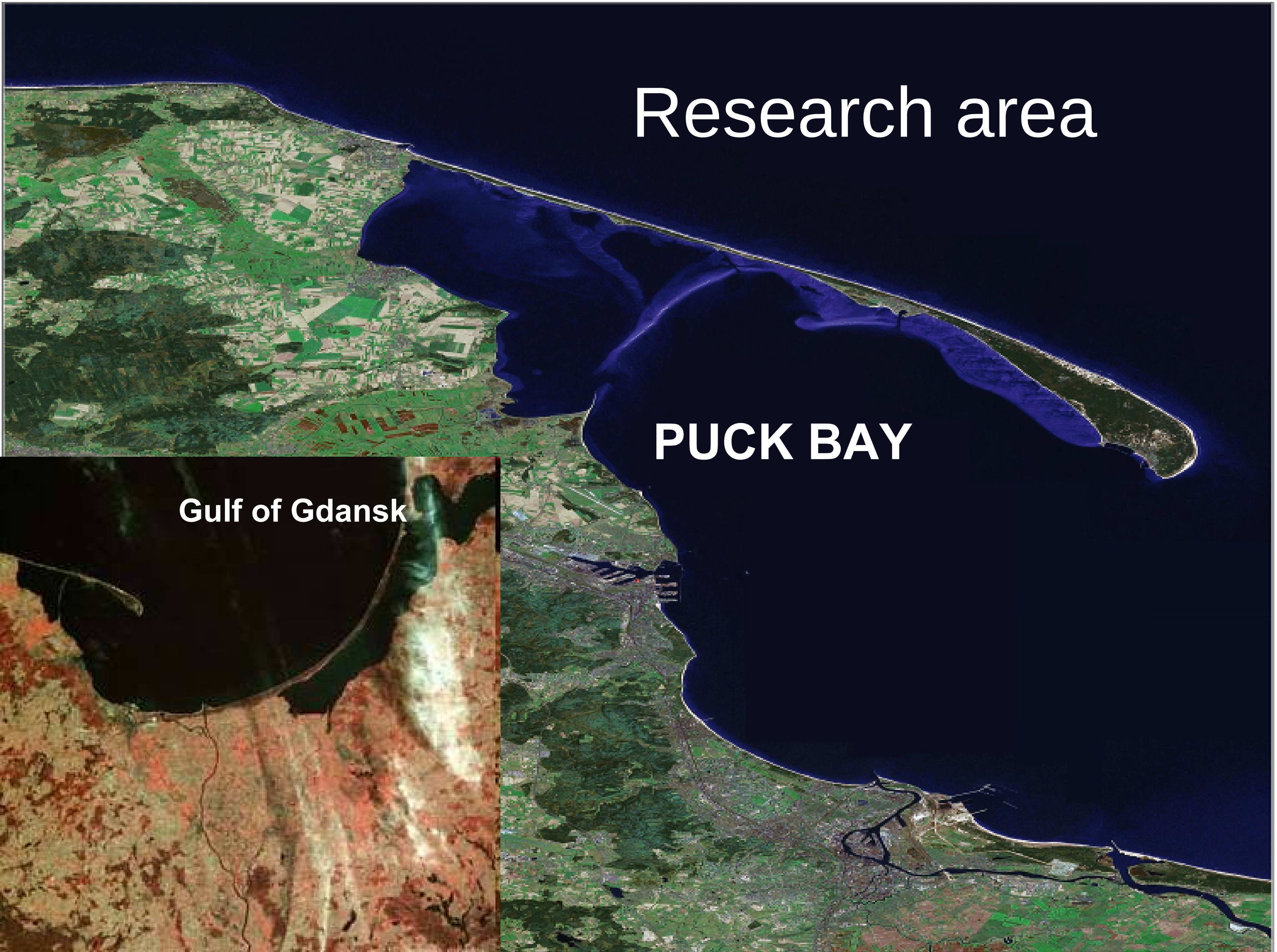
Fig. 4. Location of published investigations of submarine groundwater discharge (SGD). All studies used provided SGD estimations using seepage meters, piezometers, or geochemical/geophysical (temperature) tracers. Sites labeled "A" through "F" are locations where SGD assessment intercomparisons have been carried out. Site "A" was an initial experiment in Florida (Burnett et al., 2002) and "B" through "F" represent the five experiments reported in this paper. The numbers refer to 45 sites where SGD evaluations were identified by Taniguchi et al. (2002).

Subterranian Estuary



Seepagemeter

Fotos: Dellwig


Research area
PUCK BAY
Gulf of Gdansk

distance (m)
40
35
30
25
20
15
10
5
0
-200
-150
-100
-50
0
distance (m)
salinity
2
3
4
5
6
7
8

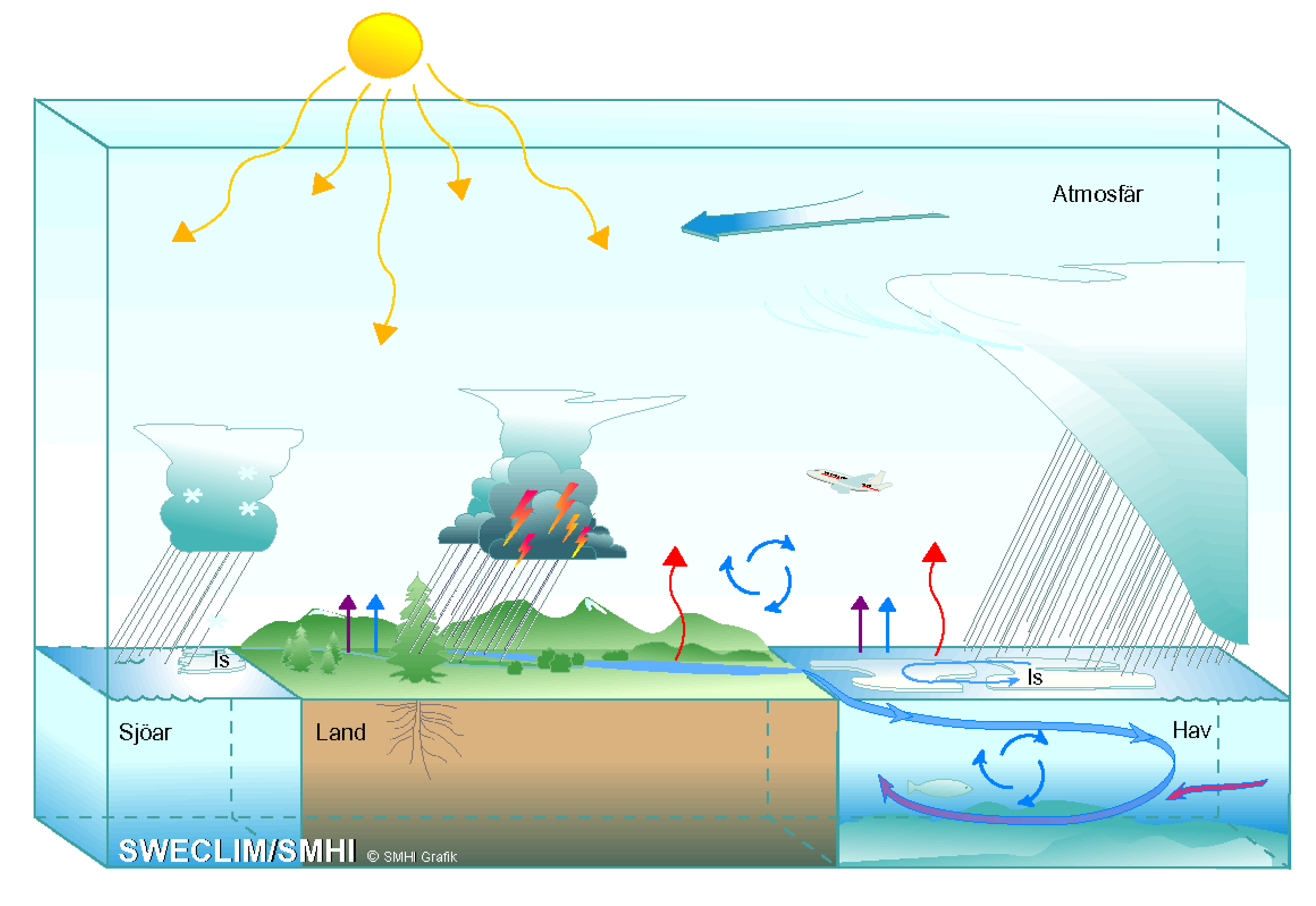
Ground Water Release

- ~ 10000 l/d per seepage (10 l/m^2 d)
- 200 µmol/l silicate
- 150 µmol/l ammonium (7.7 g N/m^2 a)
- 40 µmol/l phosphate

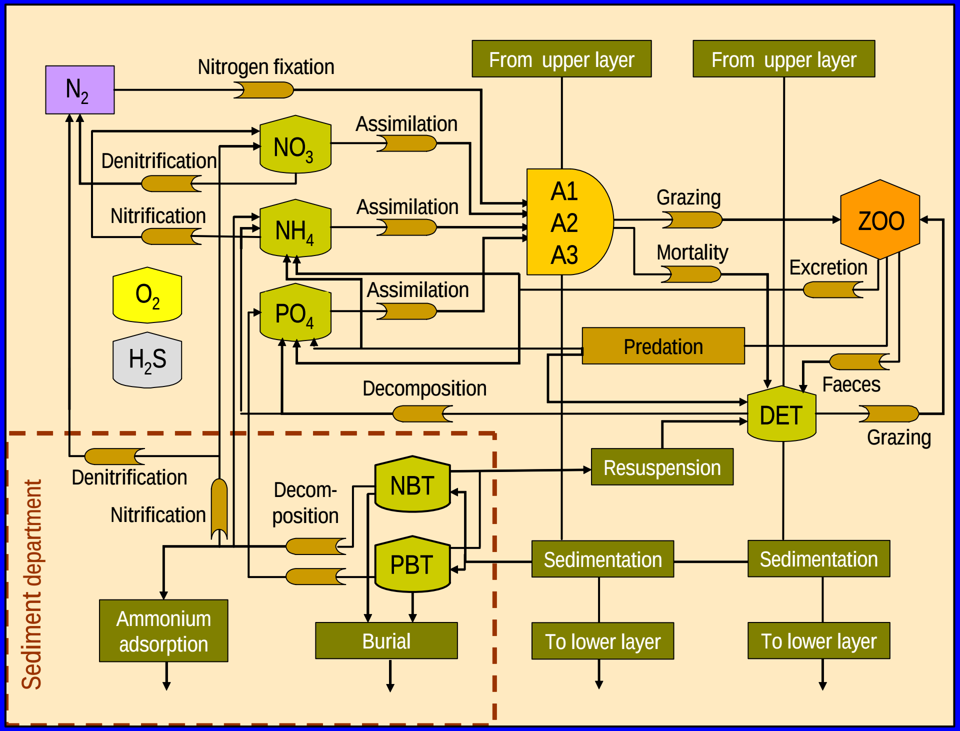
Research Cluster C

- Spatial data of Baltic river basins
- Future scenarios considering climate change and change in land use
- Detailed river basin senario studies
- River basin induced functional changes in lagoon waters
- Functional changes between coastal waters and the sea
- Biogeochemical fluxes between coastal regions and the open sea.

Atmosphere-ice-ocean-land surface model system



RCO-SCOBI High-resolution 3-D coupled physical-biogeochemical model for climate and process studies



Pelagic variables:

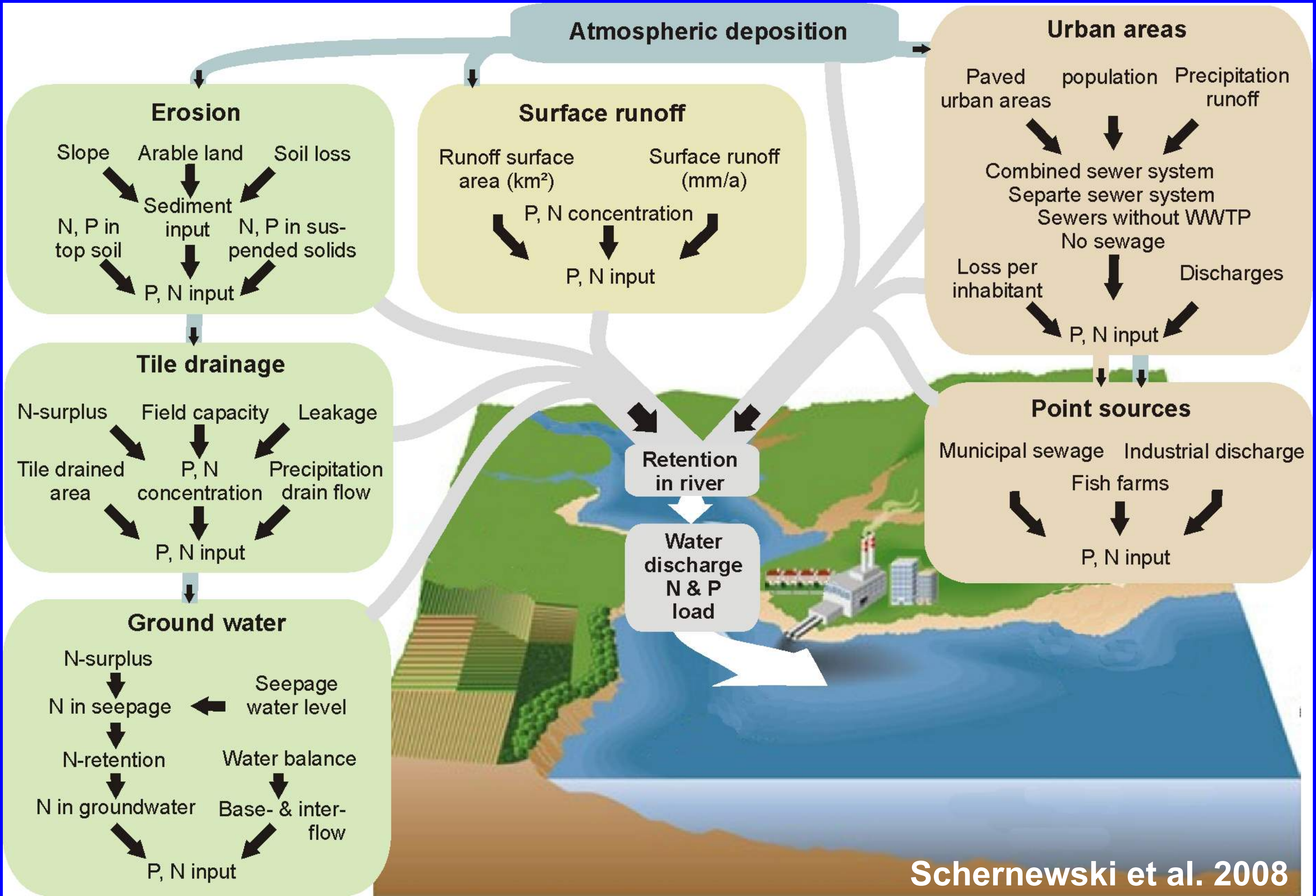
- ***nitrate*** ***(NO3)***
- ***ammonium*** ***(NH4)***
- ***phosphate*** ***(PO4)***
- ***autotrophs*** ***(A1,A2,A3)***
  (diatoms, flagellates, cyanobacteria)

- ***zooplankton*** ***(ZOO)***
- ***detritus*** ***(DET)***
- ***oxygen*** ***(O2)***
- ***Hydrogen sulfide*** ***(H2S) is included as negative oxygen.***

- **The sediment contains nutrients in the form of benthic nitrogen (NBT) and phosphorus (PBT).**
- **Aggregated process descriptions for oxygen dependent nutrient regeneration, denitrification and adsorption of ammonium to sediment particles as well as re-suspension and permanent burial of organic matter.**

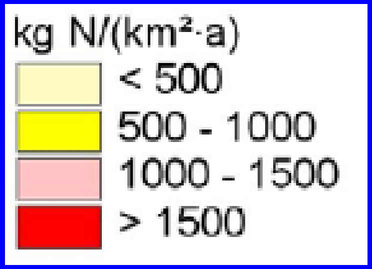
Meier et al. 2006

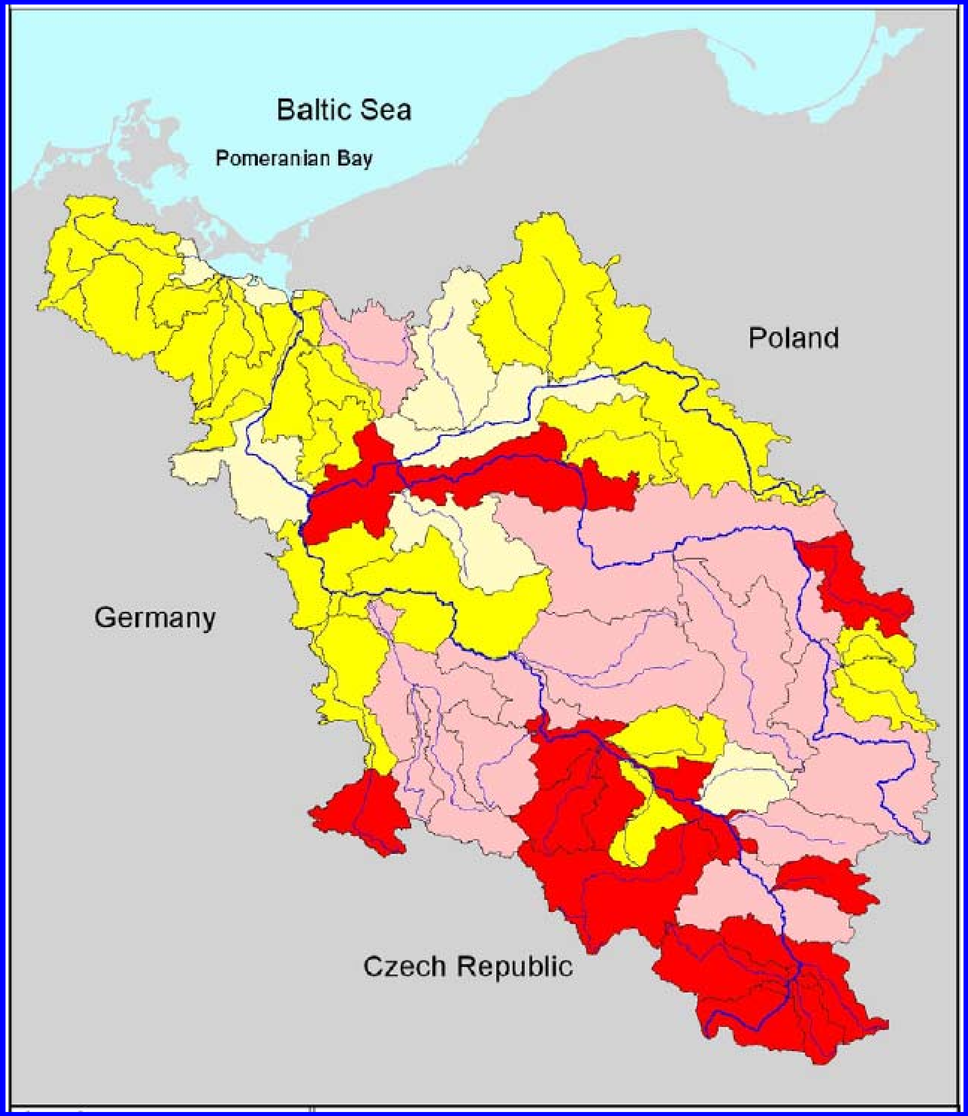
Modelling nutrient fluxes in the river basin: *The model MONERIS (with MODEST & NIIRS)*



The Oder/Odra River Basin

Total emissions: Nitrogen





Behrendt et al. (2005)

Research Cluster D

- Indicator system for ecosystem-based fisheries management
- Assessment of the effect of productivity changes in coastal areas on open-sea fish stocks
- Evaluation and modification of EQO
- Assessment of climate change impact on EQO
- Management implication for river basin-coast-sea system
- Synthesis and assessment of changes in coastal areas
- Improvement of monitoring strategies
- Risk assessment on relative contribution of land use changes vs climate change on nutrient inputs to the Baltic Sea
- Cost-benefit analysis
- Web-based information site for scientific administrative and public use

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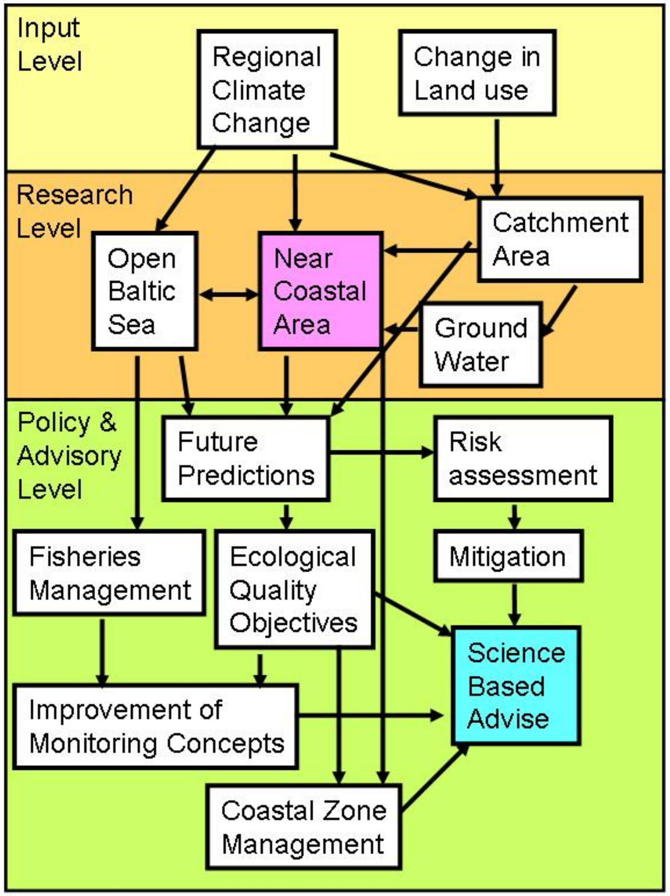
Skipped due to budget reduction

AMBER Flow Chart



Education Programme

- Workshops
  - Non-linear time series analyses
  - Stable isotopes as bio-indicators
  - Climate modelling
  - Lagoon management using ECOPATH
  - ~~Integrated caostal zone management~~
- ~~Summer school~~
  - ~~Developing ecosystem-based management strategies~~

Skipped due to budget reduction


Thank you for your attention !